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ABSTRACT

This document is a teacher's guide for a unit in the college metalworking curriculum. It is intended to be used for four weeks of instruction for freshmen as an introductory course in metalworking. The unit is designed to give the student basic knowledge, fundamentals, and skills in metalworking. The unit's objectives are to develop in students the abilities to identify various types of metals and their uses, to interpret plans used in cold metalworking, to identify and use metalworking tools, and the ability to solder. The unit is divided into material for four jobs, as follows: (1) identifying types of metal; (2) interpreting plans; (3) identifying and using metalworking hand tools; and (4) soldering. Each of the jobs includes objectives, guide questions, references, an approach to interest students, key facts about the content of the material, student learning activities, worksheets, and transparency masters. (KC)

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COLD METALWORKING AND SOLDERING

Unit A-4

by

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U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

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Vocational Instructional Services, Texas A & M University, College Station, Texas.

Oklahoma State Board of Vocational and Technical Education, Stillwater, Oklahoma.

COLD METALWORKING AND SOLDERING

Jobs Included

1. Identifying Types of Metal.
2. Interpreting Plans.
3. Identifying and Using Metalworking Hand Tools.
4. Soldering

Intended Use

This unit is intended to be four weeks of instruction for freshmen, as an introductory course in metalworking. The unit is designed to give the student basic knowledge, fundamentals and skills in metalworking.

Unit Objectives

1. To develop the ability to identify various types of metals and their uses.
2. To develop the ability to interpret plans used in cold metalworking.
3. To develop the ability to identify and use metalworking tools.
4. To develop the ability to solder.

References:

Anderson, Willard F., Thomas A. Hoerner, and V. J. Morford. Metals And Welding. St. Paul, Minnesota: Hobar Publications, 1970.

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Vocational Agriculture I. Oklahoma State Board of Vocational and Technical Education, Stillwater, Oklahoma, 1971.

Vocational Agriculture II. Oklahoma State Board of Vocational and Technical Education, Stillwater, Oklahoma, 1971.

Wakeman, T. J. and V. L. McCoy. The Farm Shop. New York, New York: The Macmillan Company, 1967.

Job I: Identifying Types of Metal.

Objectives:

The objectives of this job shall be met at a level predetermined by the instructor. The manner in which they are evaluated shall also be determined by the instructor.

Upon completion of this job, the student shall be able:

1. to determine what materials are metal.
2. to identify common metals.
3. to list uses of common metals.

Guide Questions:

1. What is the definition of metal?
2. How are various metals identified?
3. What are various metals used for?

References:

Basic Vocational Agriculture I. Vocational Instructional Services, Texas A & M University, College Station, Texas.

Parker, Marvin M. Farm Welding - Arc And Oxyacetylene Welding. New York, New York: McGraw-Hill Book Company, 1958.

Wakeman, T. J. and V. L. McCoy. The Farm Shop. New York, New York: The Macmillan Company, 1967.

Interest Approach:

Pass around samples of various types of metals and ask the students if they can identify them and what they are used for.

Key Facts:

I. Definition of Metal.

A. Substances which are crystalline when solid and are capable of being drawn out or hammered thin, and conducting electricity.

B. Sources.

1. Ore - iron or other metals mined in raw form from the earth.

2. Alloys - combinations of metals.

II. Identifying Metals.

A. Gray cast iron.

1. Grayish color.

2. Hard rough surface.

3. Easily sawed or drilled.

4. Brittle, does not bend.

5. Magnetic.

6. Spark. (Transparency 1)

a. Top is red, bottom is straw yellow.
b. 50 to 60 cm (20-25 in.) in length.

7. Other types of cast iron have some different properties.

B. Mild steel.

1. Oxidation gives a bluish gray appearance.

2. Easily sawed, drilled or welded.

3. Bendable and malleable.

4. Magnetic.

5. Sparks. (Transparency 1)

a. White.
b. About 180 cm (70 in.) in length.

C. Machinery steel.

1. Appearance is same as mild steel.

2. Somewhat harder and heavier than mild steel.

3. Magnetic.

4. Sparks similar to mild steel.

D. Tool steel.

1. Appearance is same as mild steel.

2. Usually harder and less bendable than mild steel depending on the heat treatment.

3. Magnetic.

4. Sparks. (Transparency 1)

   a. White.
   b. Very explosive at end.
   c. About 140 cm (55 in.) in length.

E. Aluminum.

1. White-gray color.

2. Very light weight.

3. Sheet aluminum is workable, easy to bend. Cast aluminum is brittle.

F. Copper.

1. Orange-gold color.

2. Easily scratched.

3. Often used to make alloys.

G. Brass.

1. Yellow-gold color.

2. Hard and durable.

3. Made from zinc and copper.

H. Bronze.

1. Color is similar to copper.

2. Harder and more durable than brass.

3. Made from copper and tin.

I. Tin.

1. Silvery color.

2. Soft.

3. Easily bent.

J. Zinc-tin alloy.

1. Color somewhat darker than tin with flaked appearance.

2. Qualities similar to tin.

(Caution: Grinding of nonferrous metals is not recommended except for extremely short intervals. The oxides given off may be toxic. Very few nonferrous metals will spark.)

III. Uses of Metals.

A. Cast iron.

1. Rough gears.

2. Engine blocks.

3. Plowshares.

4. Cultivator shovels.

B. Mild steel.

1. Braces.

2. Bolts and rivets.

3. Steel buildings.

C. Machinery steel.

1. Machinery parts.

2. Heavy braces.

3. Shafts.

D. Tool steel.

1. Cutting tools.

2. Hammers.

3. Engine crankshaft.

E. Aluminum.

1. Small engine parts.

2. Siding for buildings.

3. Electrical wire.

4. Car and appliance trim.

F. Copper.

1. Plumbing.

2. Electrical wire.

G. Brass.

1. Hardware.

2. Plumbing fittings.

3. Small gears.

H. Bronze.

1. Bearings.

2. Propellers.

3. Pennies.

I. Tin.

1. Coating for cans.

2. Utensils.

3. Roofing.

J. Zinc-tin alloy.

1. Used as a plating on tin roofing and electric tools.

2. Plating is called galvanized.

Student Learning Activities:

1. Have the students examine each type of metal to become familiar with its appearance.

2. Demonstrate proper use of the grinder and show the sparks of each of the ferrous metals. Have the students demonstrate proficiency using the grinder.

3. Give the students unknown samples and have them identify each. Make sure they use the grinder on ferrous metals.

4. Have the students complete the worksheet on identifying metals and their uses. The correct order is F D E H C A G B J I.

5. Have the students find examples at home of as many metals as possible. Have them explain how each was identified and what used for.

Worksheet 1.

Match each metal to its identifying characteristics or uses below. Each letter is used only once.

A. Cast Iron
B. Mild Steel
C. Machinery Steel
D. Tool Steel
E. Aluminum
F. Copper
G. Brass
H. Bronze
I. Tin
J. Zinc-Tin Alloy

Characteristics:

_____ Orange-gold color, easily scratched.

_____ Bluish gray, very hard, sparks white, 140 cm, exploding.

_____ White-gray color, very lightweight.

_____ Copper-tin alloy, very hard and durable.

_____ Used for making machinery frames and parts.

_____ Gray color, hard rough surface, brittle, sparks red at top, straw yellow at bottom.

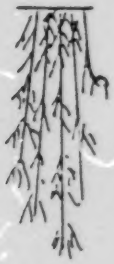
_____ Used for hardware, plumbing fittings and small gears.

_____ Bluish gray color, bendable, sparks white, 180 cm.

_____ Used for galvanizing tin roofing and electric tools.

_____ Silvery color, heavier than aluminum.

SPARK IDENTIFICATION ON HIGH SPEED GRINDER

METAL	SPARK STREAM	COLOR STREAM LENGTH
Cast Iron		Top-Red Bottom-Straw Yellow 20" to 25"
Mild Steel		White About 70"
Tool Steel		White About 55"

Courtesy of Vocational Instructional Services, Texas A & M University, College Station, Texas

Job 2: Interpreting Plans.

Objectives:

The objectives of this job shall be met at a level predetermined by the instructor. The manner in which they are evaluated shall also be determined by the instructor.

Upon completion of this job, the students shall be able:

1. to understand the importance of a working plan.
2. to determine the types of views.
3. to interpret a working plan.

Guide Questions:

1. Why is a good working plan important?
2. What are the different types of views?
3. What are the parts of a working plan?

References:

Basic Vocational Agriculture I. Vocational Instructional Services, Texas A & M University, College Station, Texas.

How To Read Shop Drawings. The Lincoln Electric Company, Cleveland, Ohio, 1961.

Vocational Agriculture II. Oklahoma State Board of Vocational and Technical Education, Stillwater, Oklahoma, 1971.

Interest Approach:

Select one student to give directions from one location to another on a map. After explaining to that student what to do, give the others maps with symbols and road numbers blacked out. When the student has encountered sufficient difficulty, point out the importance of a complete and accurate plan.

Key Facts:

I. Importance of Using a Good Plan.

A. Eliminates guessing or experimenting on project design.

B. Don't need to rely on memory.

C. Can be used to determine problems before building.

D. Can be used to determine requirements.

1. Time.

2. Labor.

3. Tools.

4. Materials.

5. Cost.

E. Can be submitted to a lender if the project is large and requires financing.

F. Can be kept on file for future reference.

II. Types of Views.

A. Orthographic.

1. 2-dimensional (flat) objects are drawn with one view.

2. 3-dimensional objects are drawn with 3 views. (Transparency 1)

a. Top.
b. Front.
c. Side.

B. Isometric and oblique views are 3-dimensional. (Transparency 2)

III. Parts of a Plan.

A. Scale.

1. Relationship of size from actual to drawing.

2. The units on the drawing must be converted to the units on the actual project. The distances listed will be the actual units, however.

3. Size change may be larger or smaller.

4. Examples of scales. (Note: drawing listed first.)

a. 1/2 in. = 1 ft.
b. 5 cm = 1 cm.
c. 1/8 in. = 1 in.
d. 1 cm = 1 m.

B. Lines. (Transparencies 3 and 4)

1. Border lines - used to frame the drawing.

2. Object lines - main lines showing outside edges of the object.

3. Hidden lines - broken line indicating lines hidden from view.

4. Center lines - alternating long and short lines showing the center of the object or other feature.

5. Dimension lines - lines with arrows and distances showing actual distance between 2 points. May be inside or out.

6. Extension lines - lines which aid in determining points where dimension lines begin and end.

7. Break line - line with jagged sections showing that the line is not in proportion, but much longer. The dimension listed must be accurate, however.

8. Leader lines - lines used as pointers to help indicate various things.

C. Dimensions. (Transparency 5)

1. Used with dimension lines.

2. Tells the distance of the actual object.

3. All distances should be listed.

4. Diameter should be given for circles.

D. Symbols used with cold metal.

1. IR - iron.

2. CI - cast iron.

3. B/M - bill of materials.

4. SST - stainless steel.

5. D - diameter.

6. HOR - horizontal.

7. HCS - high carbon steel.

8. NC - National coarse thread.

9. NF - National fine thread.

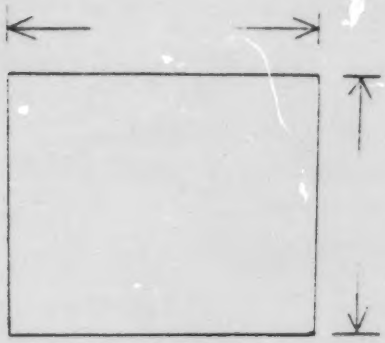
Student Learning Activities:

1. Have the students complete worksheets 1 and 2. Students will need a ruler for worksheet 1 and a key is also provided. Exact dimensions may have been changed through duplication processes so please note this when handing out the assignment. The correct order for worksheet 2 is C A E B G H D.

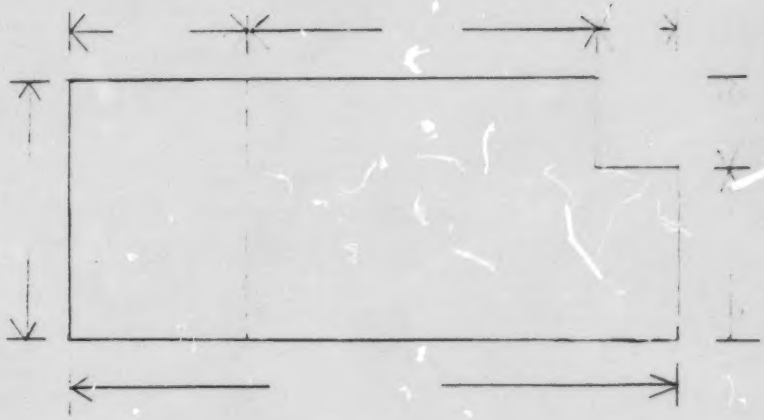
2. Have the students observe several different types of plans to become acquainted with looking at plans.

Worksheet 1

Fill in the missing dimensions by using a ruler and calculating the length using the scale given for each.



SCALE 1/4" = 1'



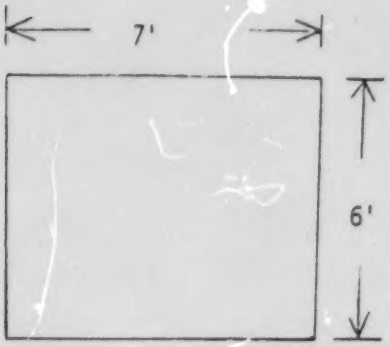
SCALE 1/2" = 1'

SCALE 5 cm = 1 cm

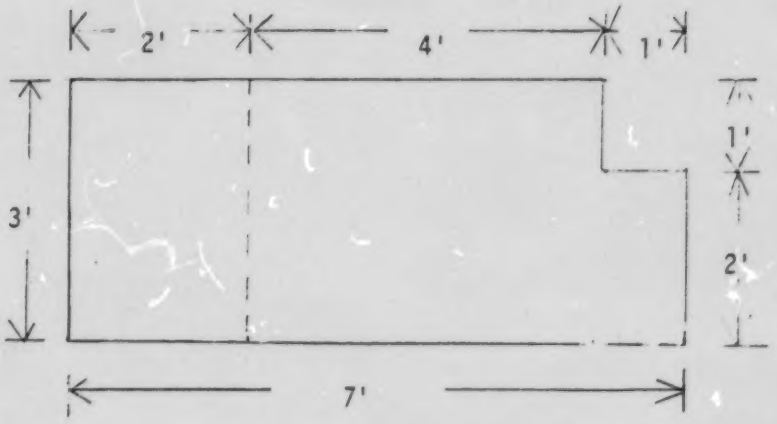
SCALE 4 cm = 1 m

Worksheet 1 KEY

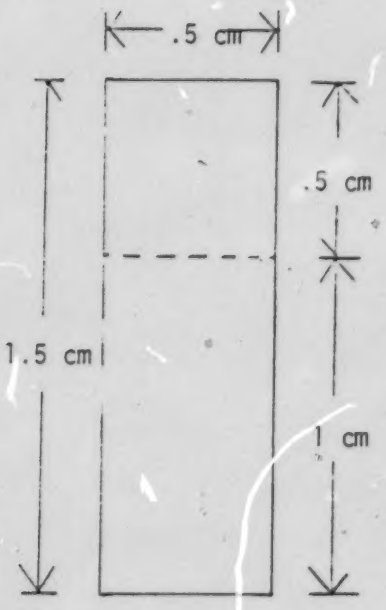
Fill in the missing dimensions by using a ruler and calculating the length using the scale given for each.



SCALE 1/4" = 1'



SCALE 1/2" = 1'



SCALE 5 cm = 1 cm

SCALE 4 cm = 1 m

MATCH THE LINES WITH THE CORRECT NAMES BELOW.

___ HIDDEN LINE

___ CENTER LINE

___ BORDER LINE

___ DIMENSION LINE

___ OBJECT LINE

___ LEADER LINE

___ BREAK LINE

___ EXTENSION LINE

A.

B.

C.

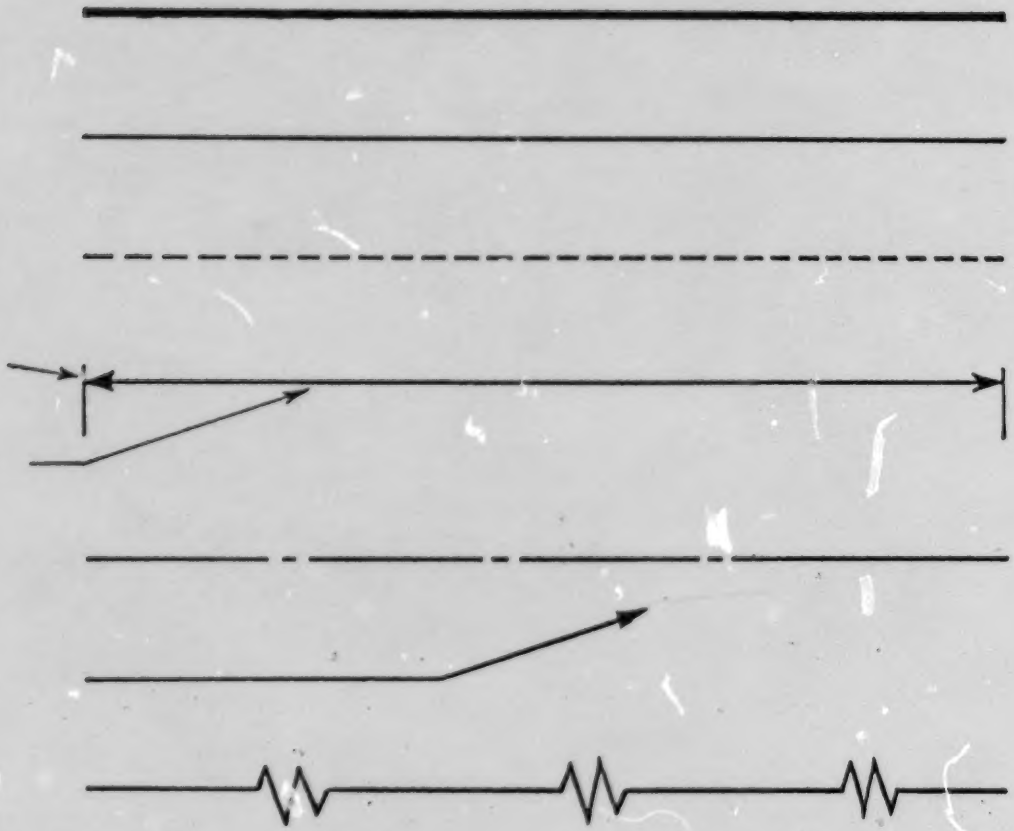
D.

E.

F.

G.

H.



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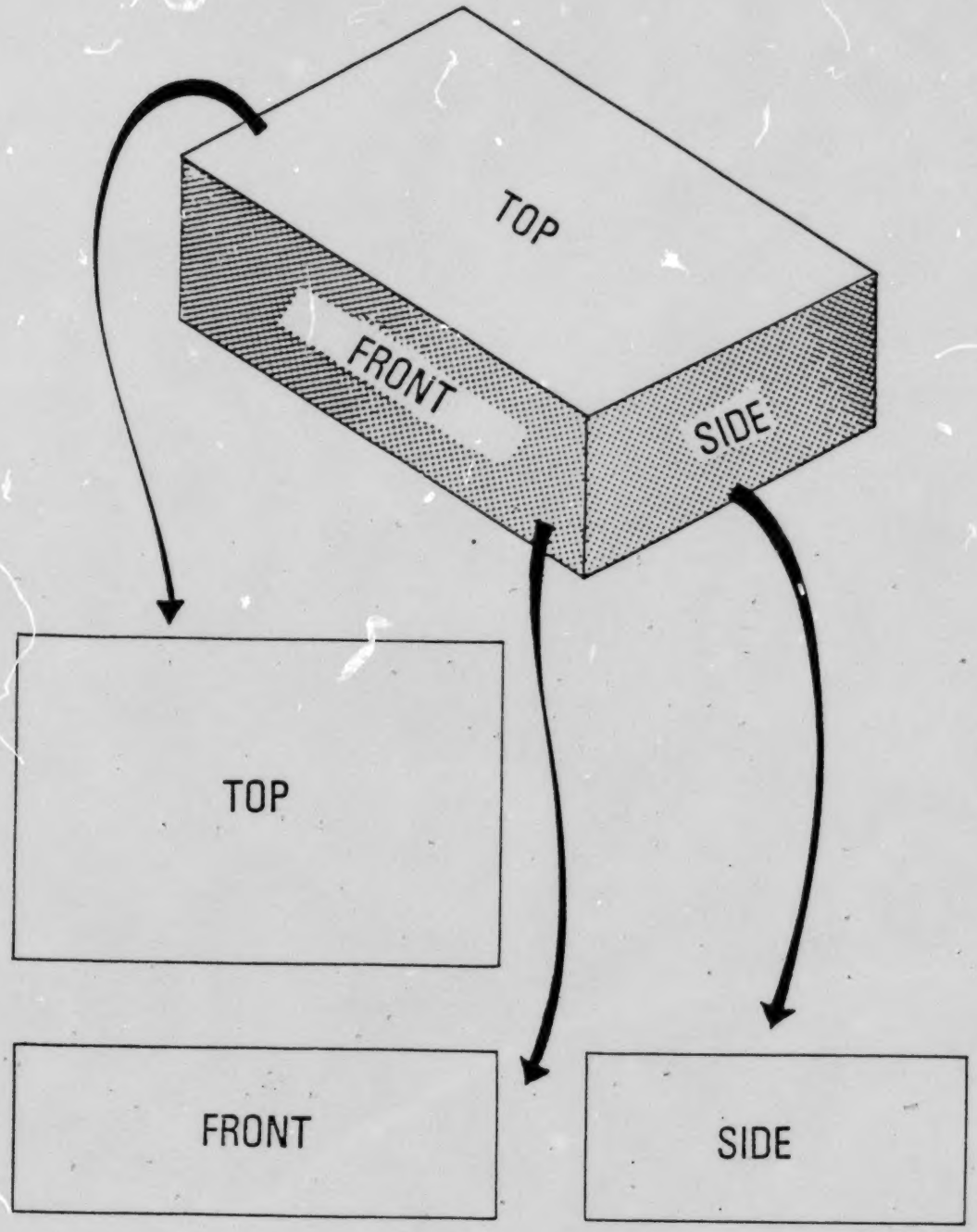
CONVERTING A PICTORIAL VIEW INTO A 3-SIDED VIEW



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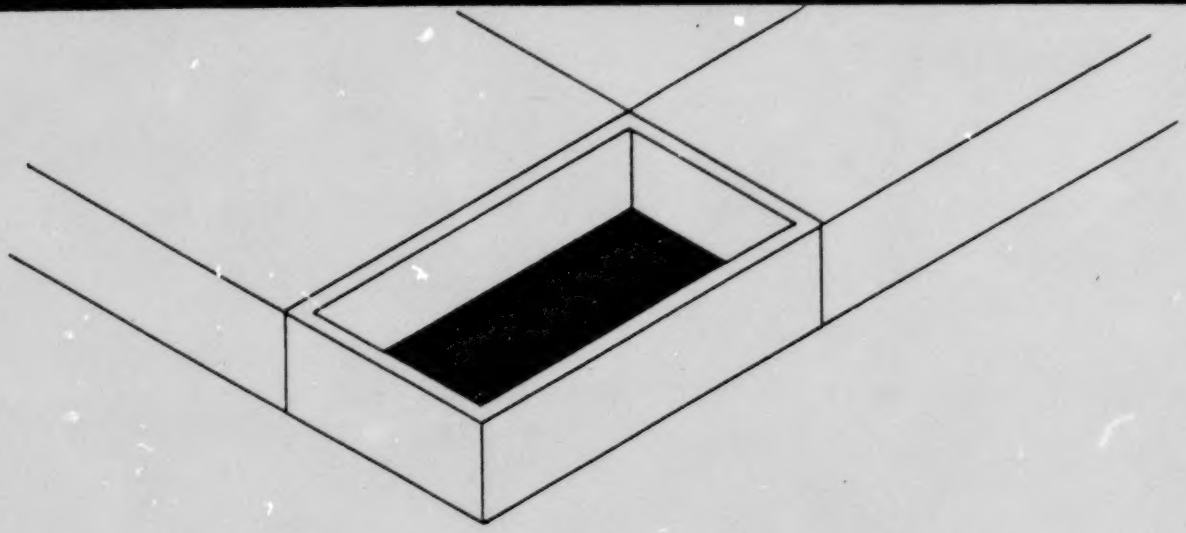
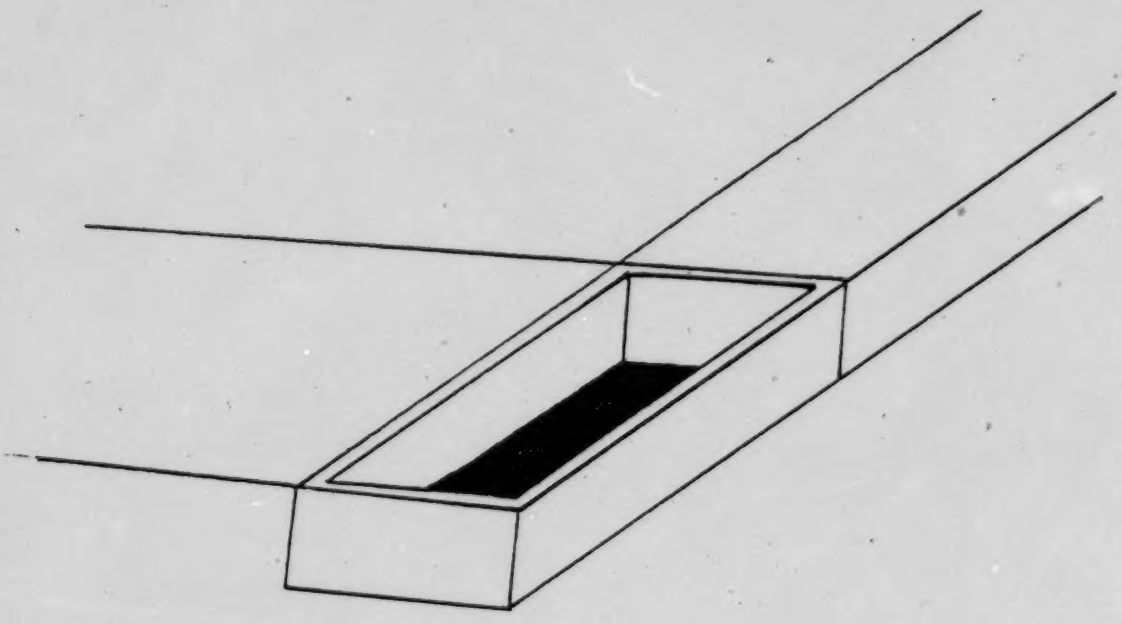
TWO DRAWINGS OF A WATER TANK



ISOMETRIC



OBLIQUE

Courtesy of Vocational Instructional Services, Texas A & M University, College Station, Texas

Basic Lines Used in Drawing and Sketching

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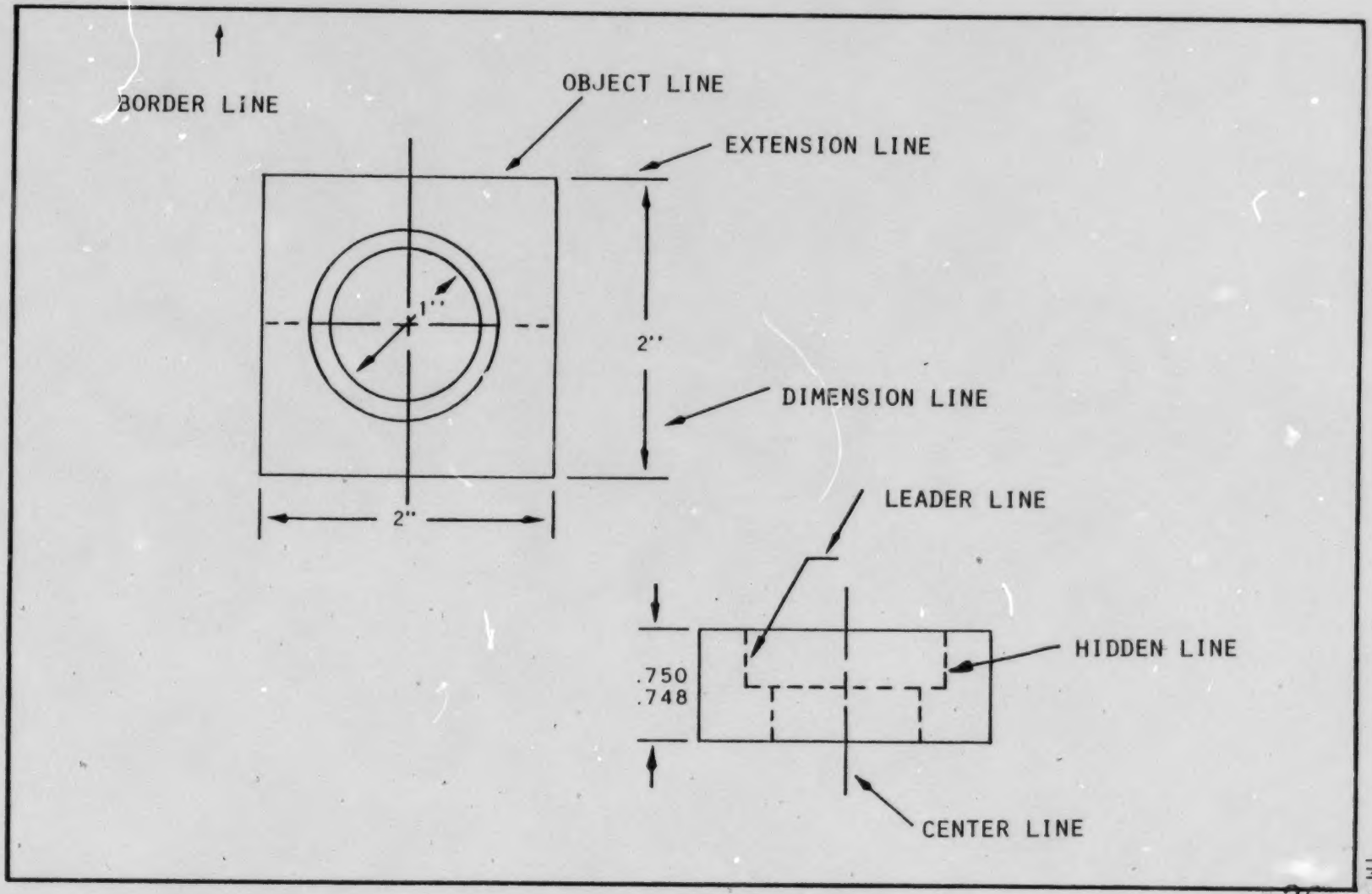
Use of Lines on a Drawing



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Types of Dimensions on a Drawing

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Job 3: Identifying and Using Metalworking Hand Tools

Objectives:

The objectives of this job shall be met at a level predetermined by the instructor. The manner in which they are evaluated shall also be determined by the instructor.

Upon completion of this job, the students shall be able:

1. to understand shop safety.
2. to identify hand tools and fasteners used in cold metalwork.
3. to properly use cold metalworking hand tools.

Guide Questions:

1. What safety factors should be considered when working in the shop?
2. What measuring tools are used with cold metal?
3. What marking tools are used with cold metal?
4. What cutting tools are used with cold metal?
5. How are files used with cold metal?
6. What bending and shaping tools are used with cold metal?
7. What drilling tools are used with cold metal?
8. What threading and tapping tools are used with cold metal?
9. What fasteners are used with cold metal?

References:

Basic Vocational Agriculture I. Vocational Instructional Services, College Station, Texas.

Phipps, Lloyd J. Mechanics in Agriculture. Danville, Illinois: The Interstate Printers & Publishers, Inc., 1977.

Vocational Agriculture I. Oklahoma State Board of Vocational and Technical Education, Stillwater, Oklahoma, 1971.

Walker, John R. Machining Fundamentals. South Holland, Illinois: The Goodheart-Willcox Company, Inc., 1973.

Interest Approach:

Display some tools which the students may not be familiar with. Ask them to identify the tools and their uses.

Key Facts:

I. General Shop Safety.

A. Safety glasses should be worn when using any tools.

B. Clothes should fit properly and not be frayed.

C. First aid supplies should be provided and easily accessed.

D. Fire extinguishers should be provided and easily accessed.

E. The instructor should be notified in case of any injury or hazardous situation.

F. Common sense and good judgement are the biggest factors in shop safety.

II. Measuring Tools. (Transparencies 1 and 2)

A. Rules.

1. Steel rule.

a. Usually 6 to 12 inches long.
b. Various graduated measures, 1/4 - 1/64 inch.
c. Used for short distances.

2. Push-pull rule.

a. Tape rolls inside case.
b. Various lengths, 3 to 25 feet.
c. Used for intermediate distances.

3. Steel tape.

a. Similar to push-pull tape but much larger and longer.
b. Generally from 25 to 100 feet.
c. Used for long distances.

B. Squares.

1. Framing square.

a. Flat, L-shaped, 16 x 24 inches.
b. Ruled on both ends.
c. Used mainly in carpentry.

2. Try square.

   a. One ruled edge, 6 inches long.
   b. Handle extends out from rule so it can be placed firmly against an edge, may be wood or metal.

3. Combination square.

   a. Similar to try square except base is adjustable and rule is 12 inches.
   b. Also has 45 degree angle.

4. T-bevel.

   a. Movable blade which can be set to any angle.
   b. Used for transferring angles.
   c. Various sizes.

C. Micrometer.

1. Precision instrument.

2. Used for measuring distances which must be accurate to the thousandth of an inch.

D. Caliper - dividers.

1. Instrument with two points used to measure a distance.

2. Adjusts to desired distance.

3. Must take the measurement from a rule or object.

4. Both inside or outside calipers for either type of measuring.

5. Dividers used in a similar manner.

III. Marking Tools. (Transparency 3)

A. Soapstone or chalk.

1. Makes white line on metal.

2. Used for rough measurements in cutting or welding.

B. Scratch awl.

1. Sharp point for scratching a mark.

2. Used with a straight edge.

C. Scriber.

1. High carbon steel tip for making mark.

2. Used same as scratch awl.

D. Compass.

1. Two sharp points, either can scratch a mark.

2. Used to mark circles or measuring like a divider and marking.

E. Center punch.

1. Marks center of circles for drilling.

2. Indentation helps drill bit stay on the mark for accuracy and safety.

F. Flat file.

1. Used on edge of metal.

2. Starts a groove for hacksawing.

IV. Cutting Tools.

A. Hacksaw. (Transparency 4)

1. Small hard teeth for cutting metal.

2. Various blades for different kinds of cutting.

3. Teeth must be close enough so at least 2 teeth are always in contact with the material being cut.

Example: 16 teeth per inch would be needed for cutting 1/8 inch material.

4. Object to be cut should be very secure, in a vise if possible.

5. Use a file to notch the starting point.

6. Use both hands to guide the saw when cutting.

7. Apply moderate pressure on the forward stroke using the full length of the blade, too much pressure may cause the blade to break. Apply no pressure on the back stroke.

8. When installing a new blade, tighten it securely keeping the teeth pointing away from the handle.

B. Cold chisel.

1. Used with a hammer to cut cold metal.

2. Several different types. (Transparency 5)

a. Flat - general cutting and chipping.
b. Cape - narrower cutting edge for grooves.

c. Round nose - cutting round grooves.
d. Diamond point - squaring corners.

3. Cutting flat metal 1/8 inch or less.

a. Mark the metal and place it in vise.
b. Hold the chisel at a 60° angle.
c. Begin at one side of the metal to start a shearing action.
d. Drive the chisel with a ball pein hammer.

4. Cutting flat metal thicker than 1/8 inch. (Transparency 6)

a. Use at least a 3/4 inch chisel and a 2 1/2 pound hammer.
b. Place the metal on the cutting edge of the anvil.
c. Make a cut on each end and continue working towards the center.
d. Flip the metal over and make the same cuts working to the center.
e. If it does not break through, it can be bent back and forth until it breaks.

5. Cutting round iron.

a. Clamp it in the vise or hold it on the cutting edge of the anvil.
b. Cut the rod 1/3 of the way through from top and bottom.
c. Bend back and forth to break it.

C. Bolt cutters. (Transparency 7)

1. Fast method for cutting round iron from 3/16 to 3/4 inch thick.

2. Capacity usually stamped on the handle.

3. Will not cut hardened steel or cable.

V. Files.

A. Two major types of teeth.

1. Single-cut.

a. Chisel-like teeth running at an angle.
b. Leaves a smooth surface.

2. Double-cut.

a. Two sets of teeth that cross each other.
b. Cuts faster but leaves a rough surface.

3. Various degrees of coarseness.

a. Bastard cut.
b. Second cut.
c. Smooth.

B. Various types of files. (Transparency 8)

1. Mill - made with only single-cut teeth.

2. Flat - similar to mill except with double-cut teeth.

3. Square - four filing sides instead of two, used for grooves.

4. Round - used for curved surfaces.

5. Half-round - one flat side, double-cut and one rounded side.

6. Tapered - used for sharpening saws.

C. Care of files. (Transparency 9)

1. All files should have a handle to prevent injury.

2. Files should be cleaned occasionally with a file card or brush.

3. Should be stored in racks away from other metals, oil and paint, to avoid damage to the teeth.

4. May shatter if dropped.

D. Use of file.

1. Fasten metal in vise.

2. Hold file by both ends.

3. Apply even pressure as the file is pushed across the work.

4. File should be lifted on the return stroke.

VI. Bending and Shaping Tools.

A. Types of tools used.

1. Vise.

2. Clamps.

3. Anvil.

4. Hammers.

a. Sledge.
b. Blacksmith
c. Ball pein.

5. Wrench.

6. Various other special tools.

B. Bending metal strips with a hammer and vise. (Transparency 10)

1. Clamp metal strip tightly to vise at the point where the bend is to be made.

2. Pound on the side until desired angle is reached.

3. Check the angle with a try square or T-bevel.

4. Heating may be necessary to prevent cracks.

C. Twisting metal. (Transparency 11)

1. Select stock which is longer than desired length. Wait till after twisting to cut to length.

2. Clamp metal in vise where twist is to start.

3. Twist metal with a wrench.

4. Excessive twisting can weaken metal. Proper twisting strengthens.

5. Prevent bending of long pieces by putting a piece of pipe over it.

VII. Drilling Tools.

A. Types of drills. (Transparency 12)

1. Portable electric drill.

a. Up to 1/2 inch thick metal.
b. Size is measured by the largest bit accepted by the chuck; 1/4, 3/8, and 1/2 inch are common sizes.
c. Can be mounted for more accurate drilling.

2. Drill press.

a. Stationary.
b. Can be used for heavier and more accurate drilling.

3. Hand drill.

a. Used for lighter, softer metal and smaller holes.
b. Various types.

B. Parts of a twist drill bit. (Transparency 13)

1. Drill point - cone shaped cutting end.

2. Cutting lip - cutting edge.

3. Body - part where grooves are cut.

4. Margin - outer part of cutting edge.

5. Flute - spiral groove.

6. Shank - end held in drill.

C. Sharpening a twist drill bit. (Transparency 14)

1. Hold the bit securely against the tool rest of the grinding wheel at a 59° angle.

2. Begin grinding on the lip and then slowly lower the shank and rotate the bit clockwise, grinding down to the trailing edge.

3. Repeat procedure on both sides until each cutting lip is sharp.

4. Keep both sides even so the point is in the exact center and both cutting lips are the same length.

5. Use a gauge to check angles.

   a. Cutting lips - 59°.
   b. Lip clearance - 8-12°.
   c. Drill point - 120-135°.

D. Drilling a hole. (Transparency 15)

1. Mark a cross at the center of the hole and center punch it.

2. Select the proper drill bit.

3. Determine and set proper drill speed. Consult a chart of drill speeds for proper RPM's.

4. Clamp the stock to be drilled securely in place; if not, it may begin to spin.

5. Lubricate both the drill bit and the hole often while drilling.

   a. Cools the drill bit and metal.
   b. Floats away metal chips.

6. Hold the drill straight and apply steady pressure. Small bits break easily so adjust pressure accordingly.

7. Reduce pressure just before the point pierces through the metal.

8. A smaller pilot hole may be drilled first when drilling large holes.

9. Drill round metal in a V-block.

VIII. Threading and Tapping Tools.

A. Two common types of threads.

1. National coarse.

2. National fine.

B. Tools used. (Transparency 16)

1. Die - cuts external threads on a rod.

2. Tap - cuts internal threads in a hole.

3. Die stock - holds die.

4. Tap wrench - holds tap.

C. Cutting external threads.

1. Select the proper die for the diameter of the stock and type of thread.

2. Clamp the stock in a vise.

3. Bevel the end with a file for easier starting.

4. Lubricate the die often with cutting oil.

5. Begin threading slowly making sure the die is straight and applying down pressure. Be sure to start with the tapered end of the die.

6. Back the die off every few turns to break up the metal chips.

D. Cutting internal threads.

1. Select the proper tap for the diameter of the hole and type of thread.

2. Clamp the stock in a vise.

3. Lubricate the tap often with cutting oil.

4. Use a square to make sure the tap is straight.
(Transparency 17)

5. Start turning, keeping the tap square and applying down pressure.

6. Remove chips as necessary.

7. Do not run the tap to the bottom of a blind hole and continue to apply pressure.

IX. Metal Fasteners.

A. Bolts and screws. (Transparency 18)

1. Machine bolt - usually threaded only part way.

2. Carriage bolt - used to connect wood to metal. Square shaft keeps bolt from turning in wood.

3. Stove bolt - threaded all the way to the head.

4. Machine screws - similar to machine bolt except for screwdriver slit head of various types. May be used with a threaded hole or a nut.

5. Sheet metal screws - cut their own threads in a hole of proper size.

B. Washers and nuts. (Transparency 19)

1. Flat washer.

2. Lock washer.

3. Hex nut - 6 sides.

4. Square nut - 4 sides.

C. Rivets.

1. Many types. (Transparency 20)

2. Setting a rivet. (Transparency 21)

a. Select a rivet to match the hole diameter.
b. Place the two pieces of metal over the rivet.
c. Draw the metal together using the deep hole of the rivet set.
d. Tighten the rivet with a hammer.
e. Use the cup-shaped hole of the rivet set to shape the rivet head.

Student Learning Activities:

1. Display each of the tools and have students examine them. Have them name each one as an exercise in identification after they have looked at each tool.

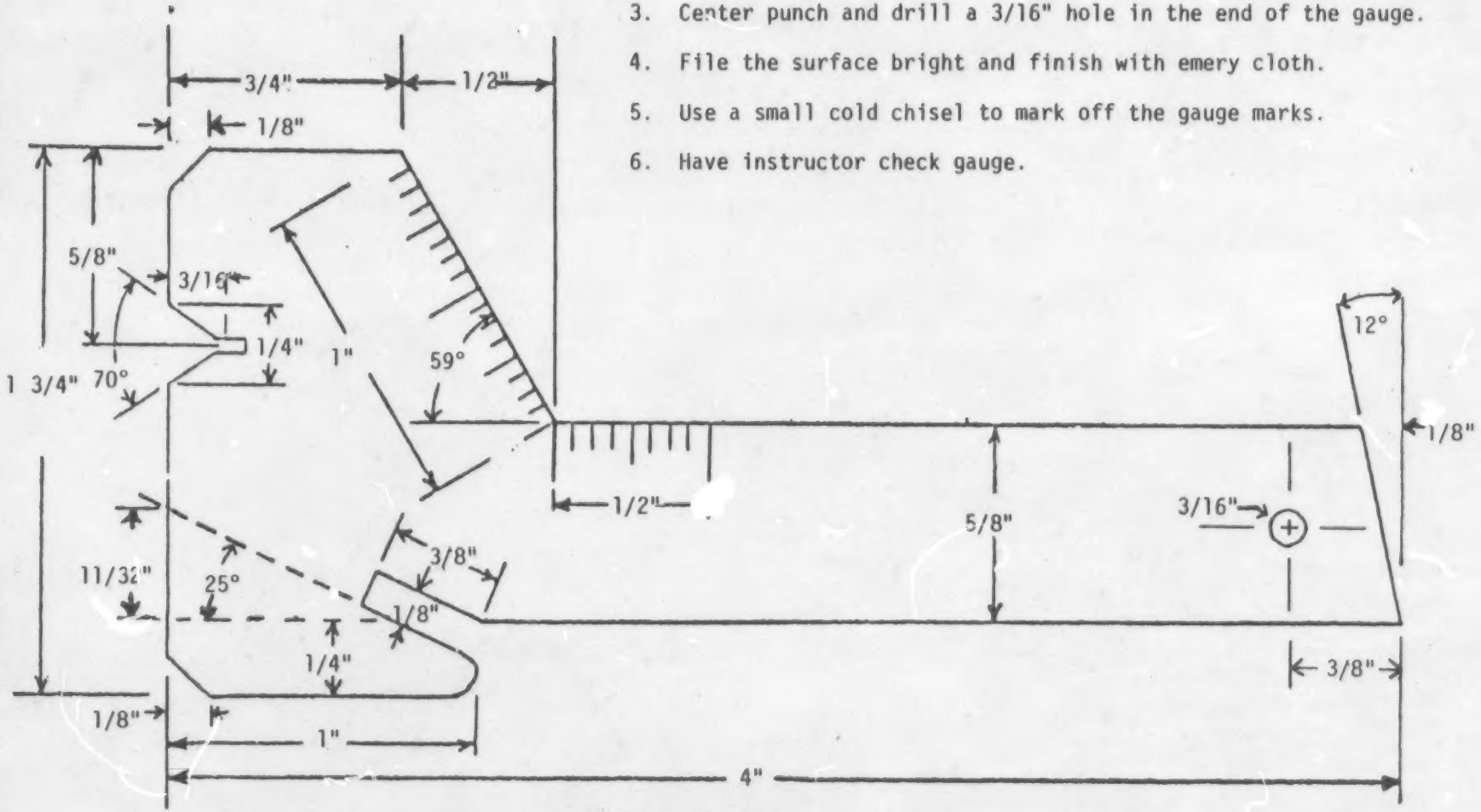
2. Demonstrate each of the skills to the students. Be sure to point out safety practices.

3. Have each of the students practice the skills until proficient.

4. Have the students select and complete a project using cold metal. Plans for a tool gauge are included on the following page which may be altered to match the ability and skills of the students.

TOOL GAUGE PLANS

1. Mark out dimensions on a piece of sheet aluminum 1/8" X 1 3/4" X 4" with a scratch awl.
2. Cut out the gauge with a hack saw and file the edges to accurate dimensions.
3. Center punch and drill a 3/16" hole in the end of the gauge.
4. File the surface bright and finish with emery cloth.
5. Use a small cold chisel to mark off the gauge marks.
6. Have instructor check gauge.

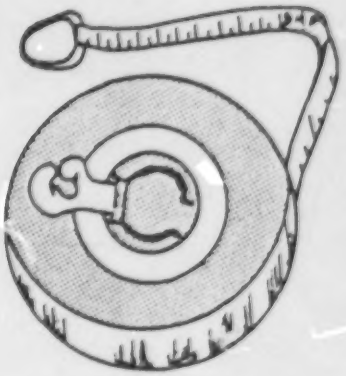


SCALE 2" = 1"

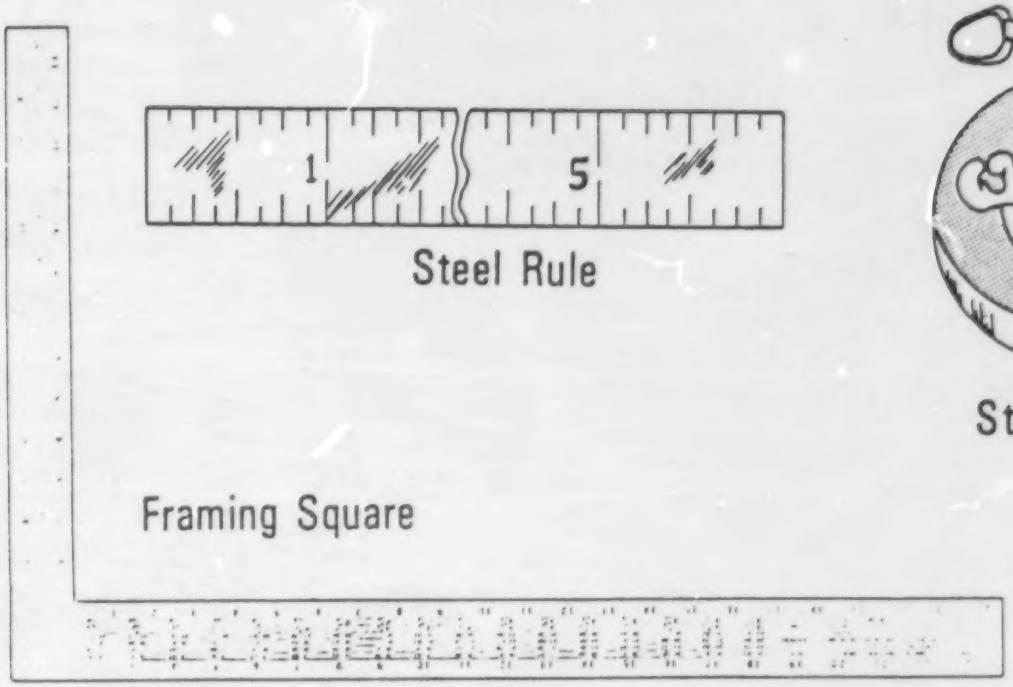
Courtesy of the Department of Agricultural Engineering, North Dakota State University.

Devices Used in Measuring Metal

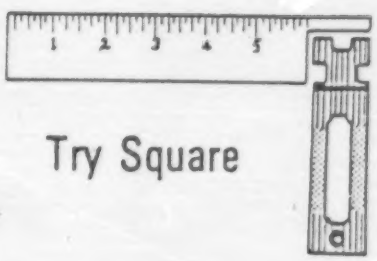
Steel Rule



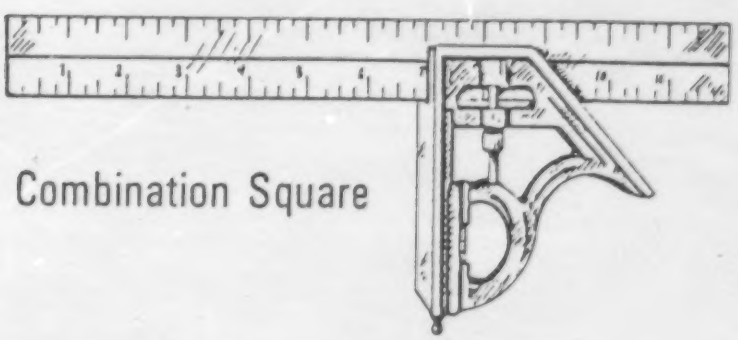
Steel Tape



Framing Square



Try Square



Combination Square

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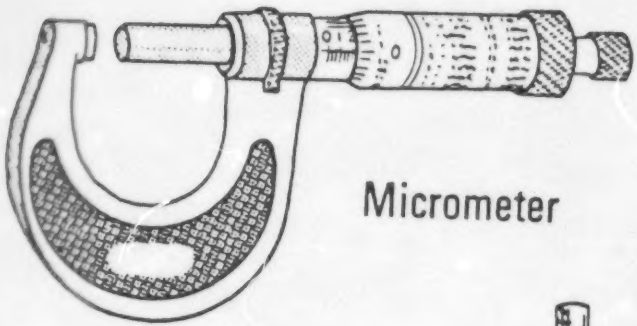
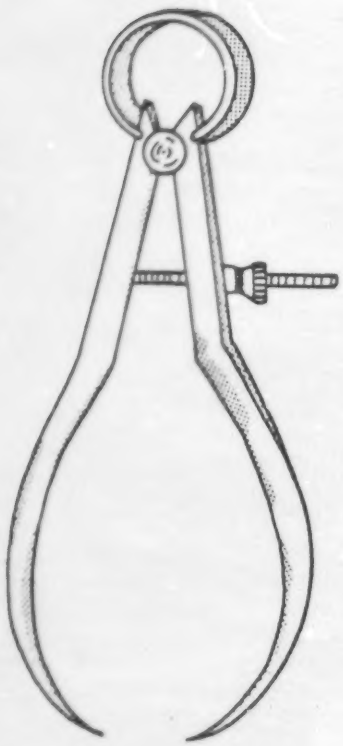
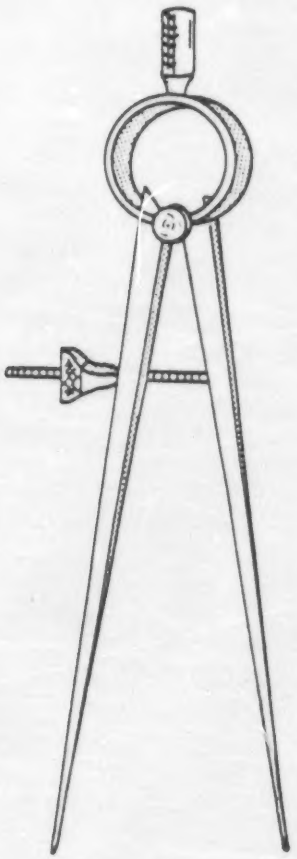
Devices Used in Measuring Metal



Micrometer



Calipers-Outside



Dividers

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Devices Used in Marking Metal

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HACKSAW

Courtesy of Vocational Instructional Services, Texas A & M University, College Station, Texas

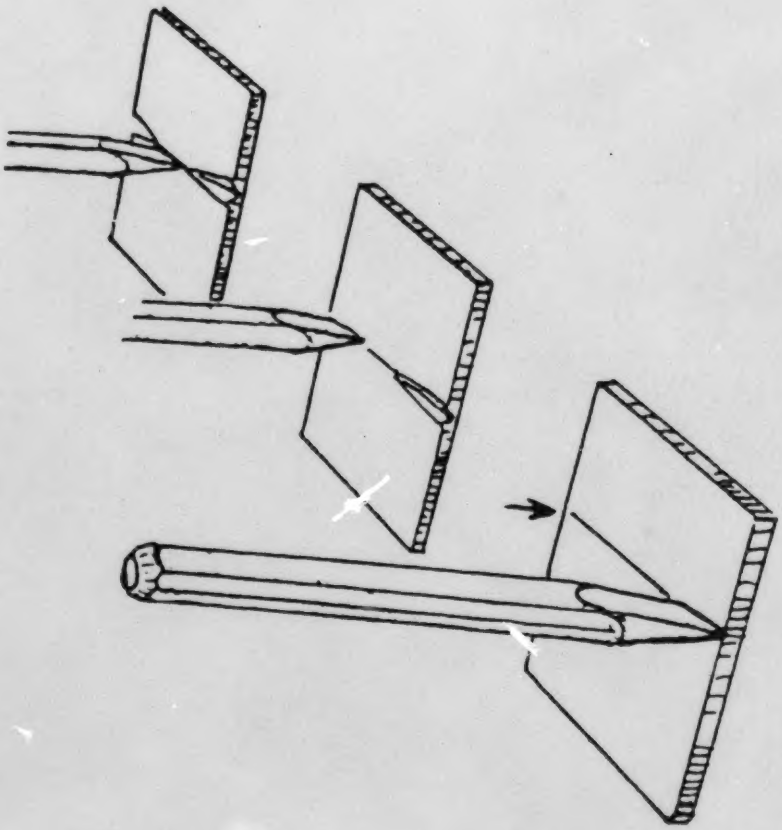
VARIOUS TYPES OF CHISEL POINTS

Flat

Cape

Round Nose

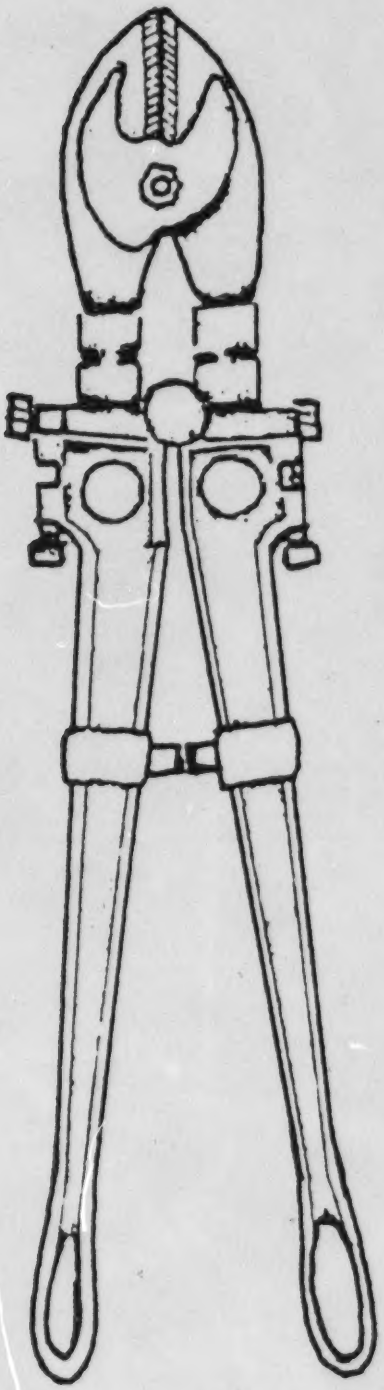
Diamond Point



START AT EACH SIDE AND WORK TO THE MIDDLE WHEN CUTTING THICK PIECES

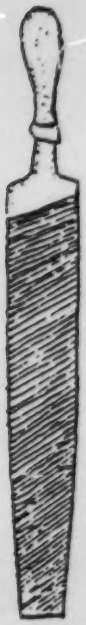
Courtesy of Vocational Instructional Services, Texas A & M University, College Station, Texas

BOLT CUTTER

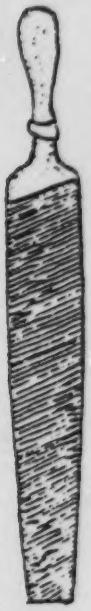


Courtesy of Vocational Instructional Services, Texas A & M University, College Station, Texas

TYPES OF FILES



mill

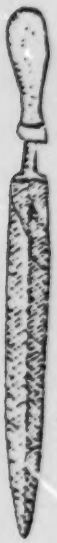


flat

square

round

half-round



tapered

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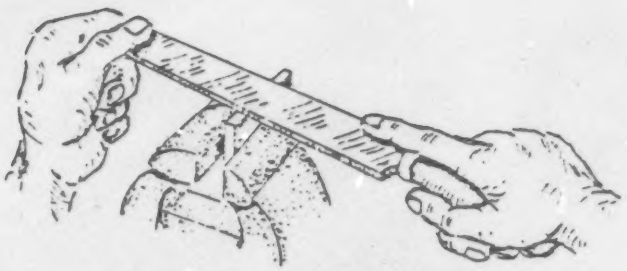
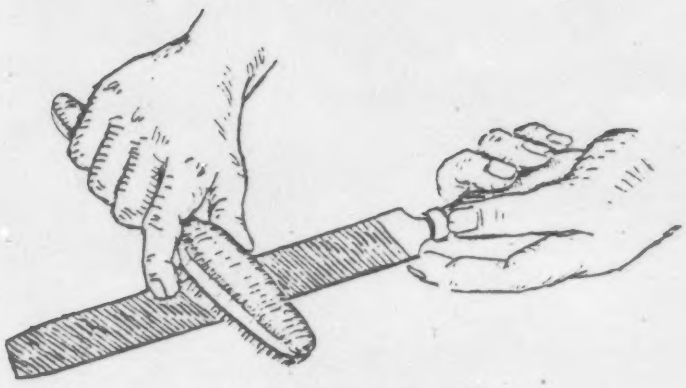
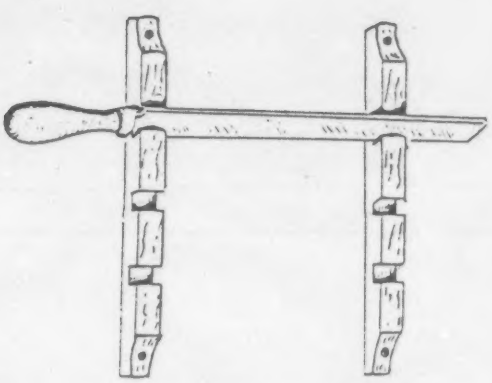
PROPER CARE OF FILES



MUST HAVE A HANDLE



CLEAN OCCAISIONALLY



STORE IN A RACK

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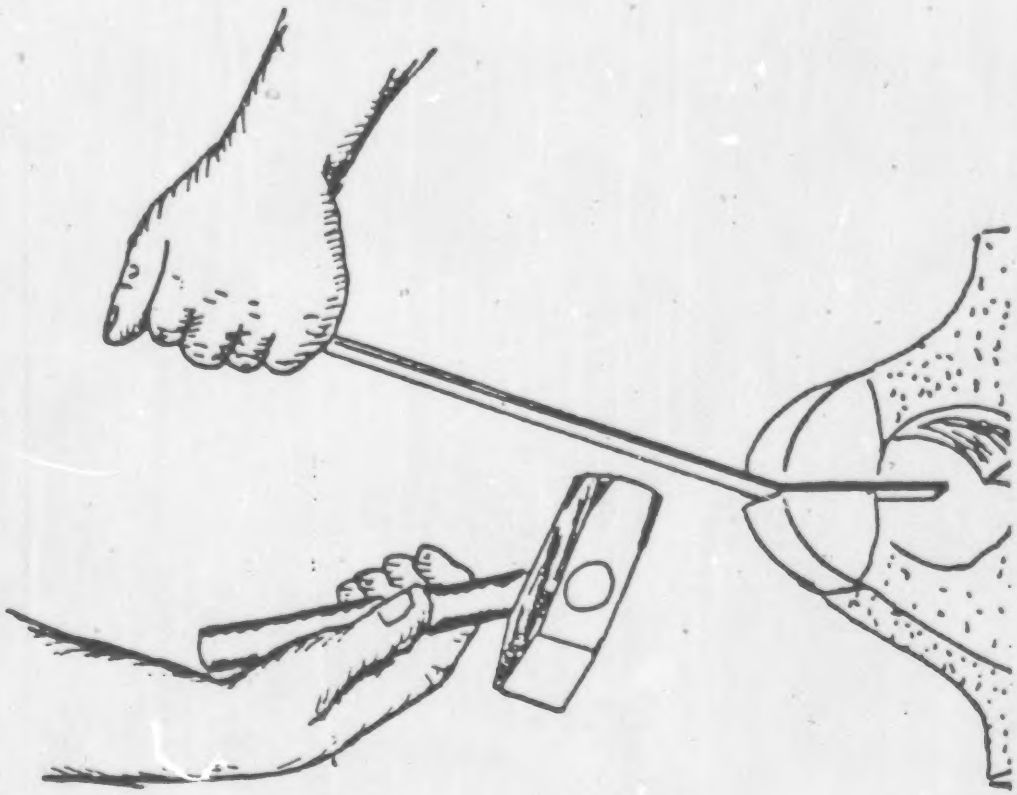

BENDING METAL WITH A HAMMER AND VISE

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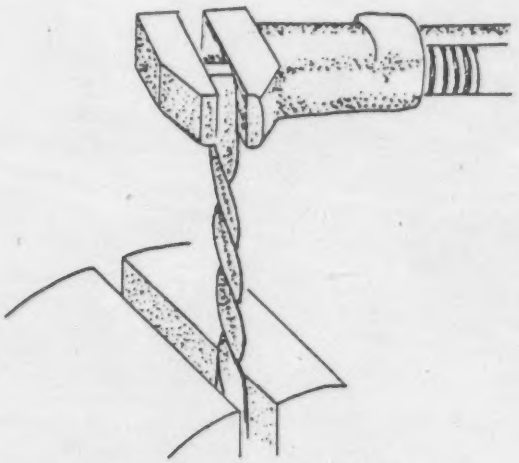
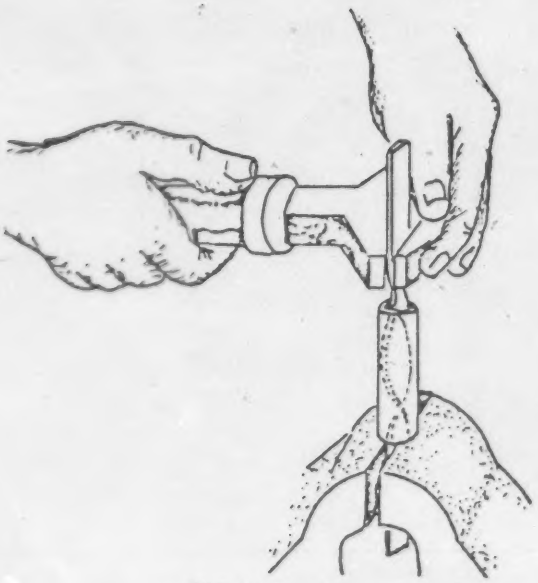
TWISTING METAL WITH A WRENCH AND VISE



Twisting Square Rod



Making Long Twists

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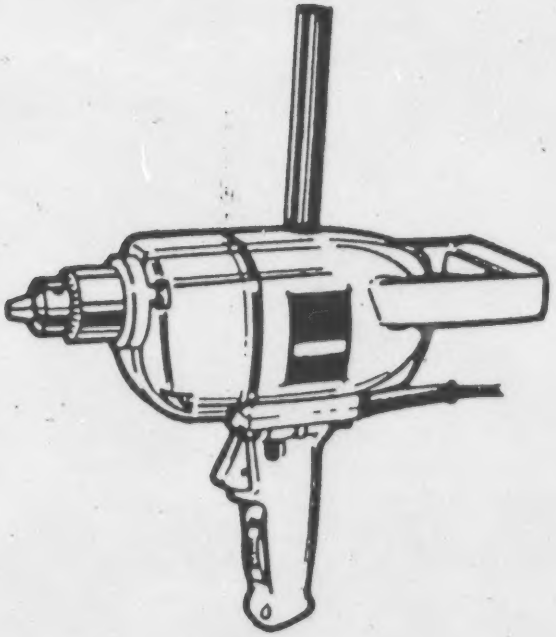
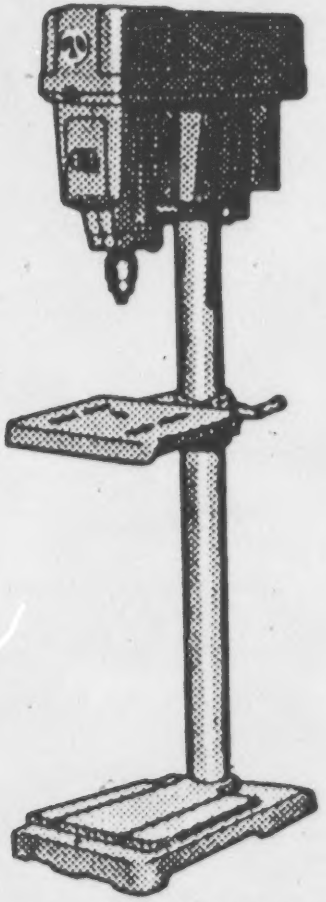
TYPES OF DRILLS



PORTABLE
ELECTRIC DRILL



DRILL PRESS

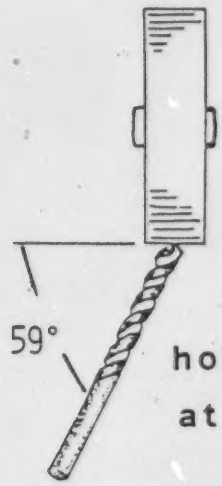
HAND DRILL

TWIST DRILL PARTS

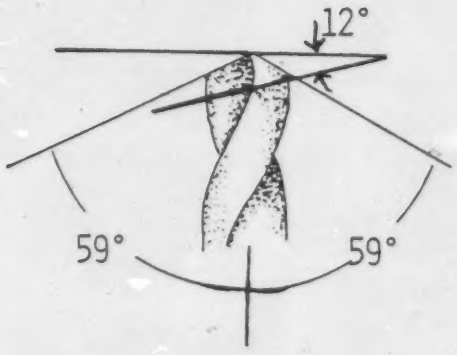
Courtesy of Vocational Instructional Services, Texas A & M University, College Station, Texas

SHARPENING A TWIST DRILL

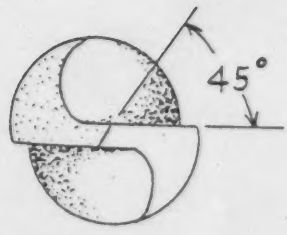
beginning sweep with drill



hold drill at angle



correct bit angles



correct center point

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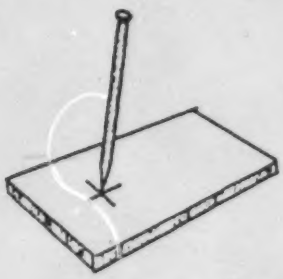
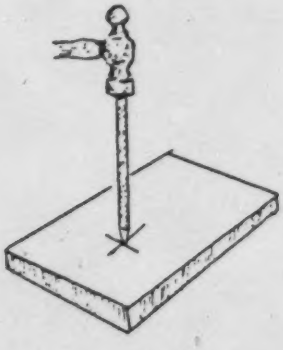
DRILLING A HOLE IN COLD METAL

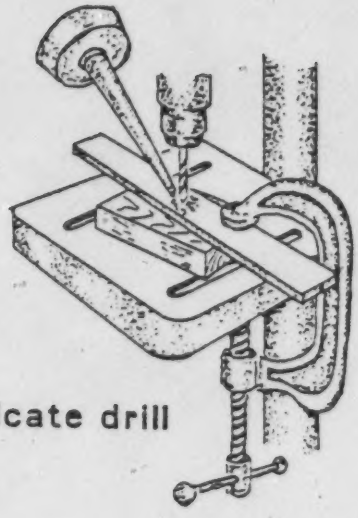
A-4-3
TM 15



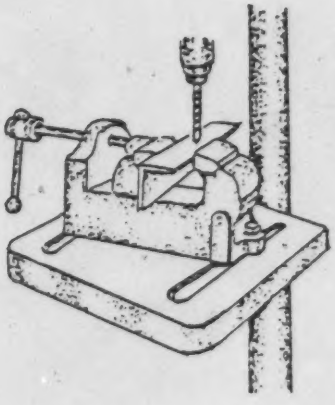
center by making a cross



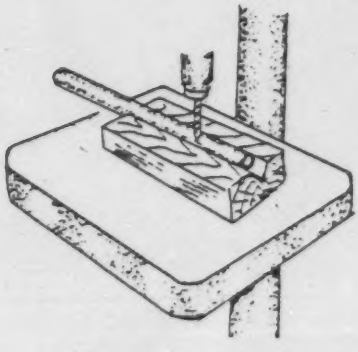
dent with center punch



lubricate drill



vise for drill press



drill round metal
with V-block

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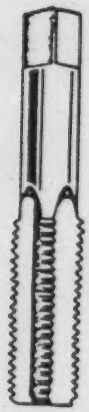
THREADING TOOLS

DIE

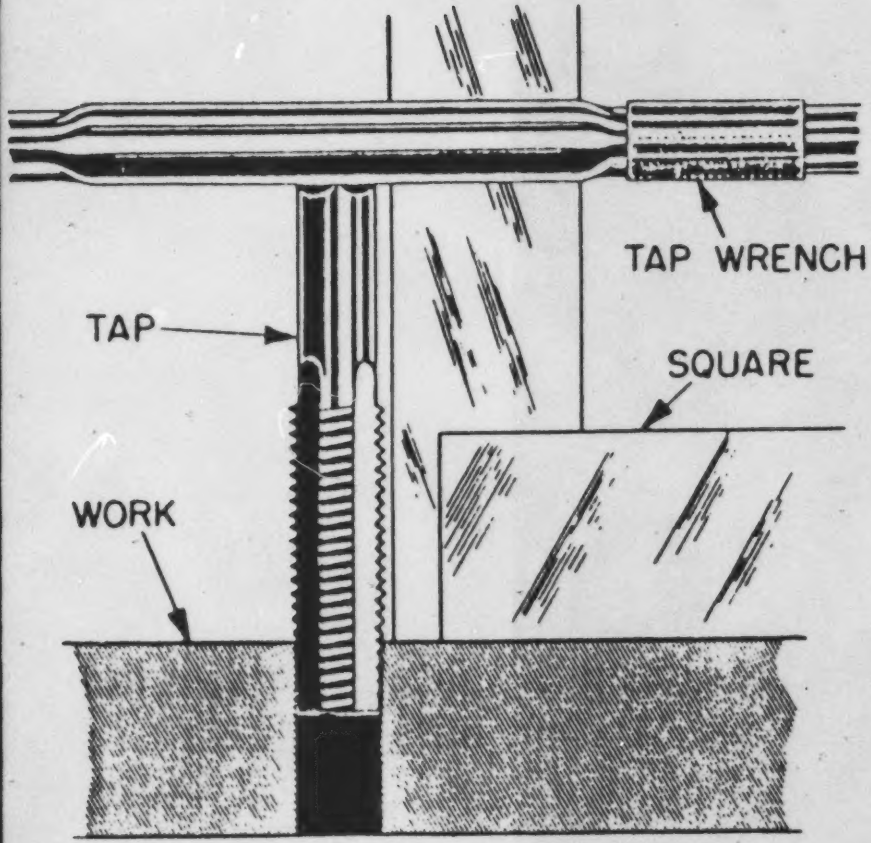


TAP

die stock

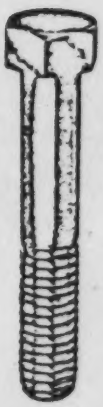
tap wrench

Courtesy of Vocational Instructional Services, Texas A & M University, College Station, Texas



USE A SQUARE TO MAKE SURE THE TAP IS STRAIGHT

BOLTING IN METAL WORK



MACHINE

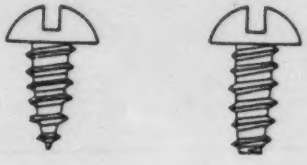
CARRIAGE

STOVE

BOLTS

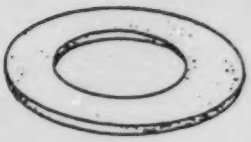
ROUND FILLISTER FLAT

MACHINE SCREWS

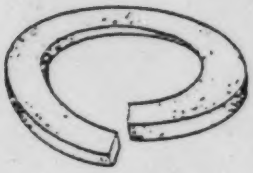


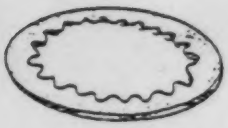
SHEET METAL SCREWS

WASHERS AND NUTS



FLAT WASHER





LOCK WASHERS

HEX NUT

Courtesy of Vocational Instructional Services, Texas A & M University, College Station, Texas

RIVET HEADS

truss

button

countersunk
round top

cone

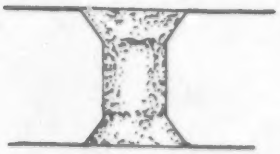
flat

tinner's

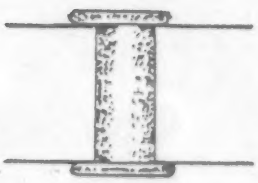
countersunk
flat top

pan

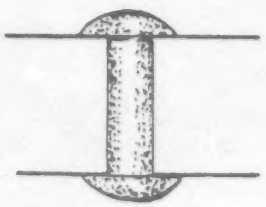
RIVETS SET



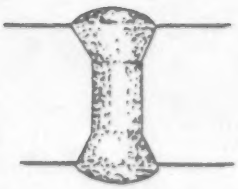
countersunk
with hammer



flat head
with hammer



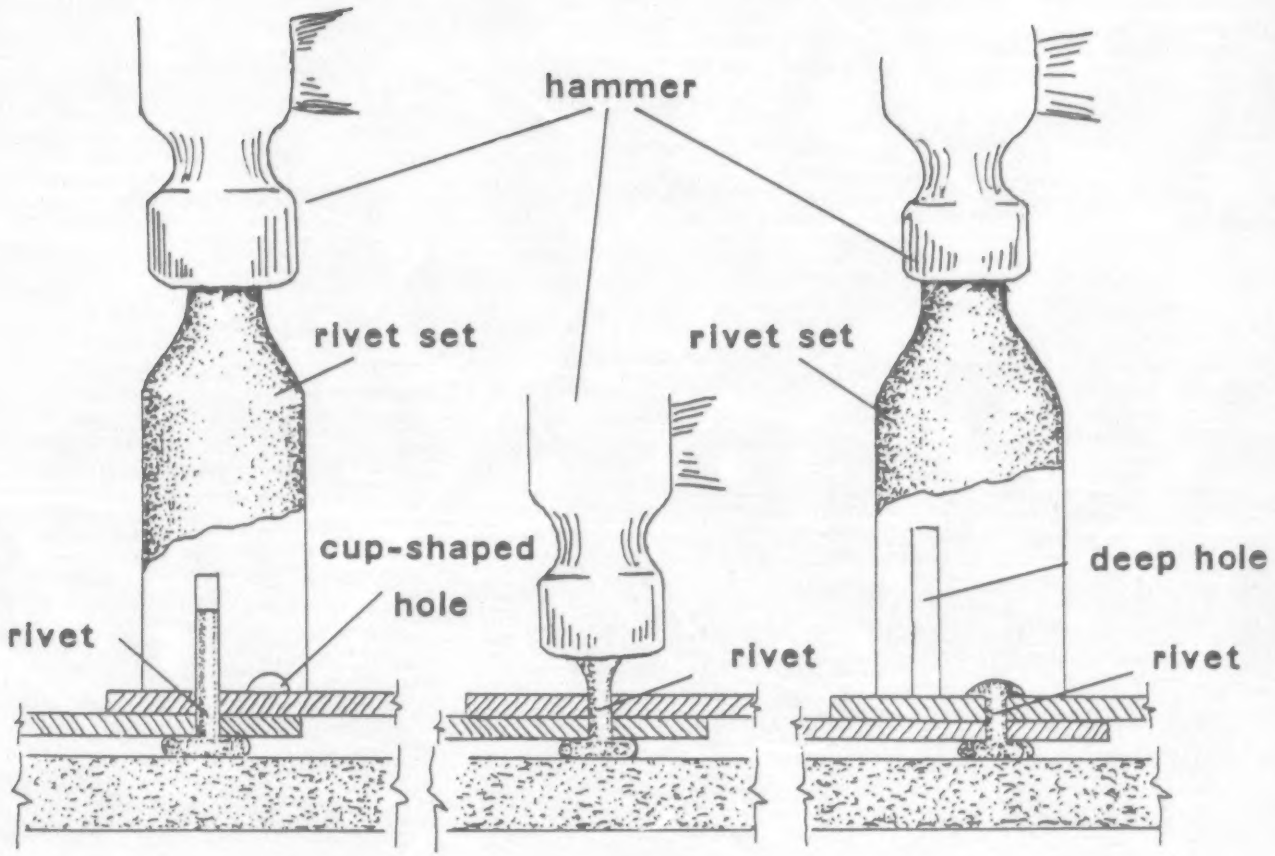
round head
with hammer



countersunk
with round top

Courtesy of Vocational Instructional Services, Texas A & M University,
College Station, Texas

SETTING A RIVET



Courtesy of Vocational Instructional Services, Texas A & M University, College Station, Texas

Job 4: Soldering

Objectives:

The objectives of this job shall be met at a level predetermined by the instructor. The manner in which they are evaluated shall also be determined by the instructor.

Upon completion of this job, the students shall be able:

1. to understand what soldering is.
2. to list different methods of soldering.
3. to understand the proper use of flux.
4. to tin a soldering iron.
5. to solder electrical connections and copper tubing.

Guide Questions:

1. What is soldering?
2. What are the different methods of soldering.
3. What is flux used for?
4. How is a soldering iron tinned?
5. How are electrical connections soldered?
6. How is copper tubing soldered?

References:

Phipps, Lloyd J. Mechanics in Agriculture. Danville, Illinois: The Interstate Printers & Publishers, Inc., 1977.

Sampson, Harry O., Albert S. Mowery and Harold L. Kugler. Farm Shop Skills. Chicago, Illinois: American Technical Society, 1959.

Wakeman, T. J. and V. L. McCoy. The Farm Shop. New York, New York: The Macmillan Company, 1967.

Interest Approach:

Display a soldering iron, a soldering gun, and a propane torch and ask the students if they know what these things all have in common.

Key Facts:

I. Definition of Soldering.

A. Process of fastening pieces of metal together using a material with a lower melting point than the pieces.

B. Solder is a tin and lead alloy.

C. Uses of soldering.

1. Electrical connections.

2. Copper tubing.

3. Patching holes.

II. Methods of Soldering (Transparency 1).

A. Soldering iron and gas furnace.

1. Iron is heated in furnace.

2. Should have two so one can heat while the other is being used.

3. Generally used for patching holes.

B. Electric soldering iron.

1. Similar to nonelectric iron.

2. Tip should be interchangeable.

C. Electric soldering gun.

1. Smaller tip than iron.

2. Trigger is on/off switch.

3. Tip is replaceable.

4. Used for making electrical connections and other small work.

D. Propane torch.

1. Lightweight and portable.

2. May be used indoors or outside.

3. No soot or smoke is produced.

III. Flux

A. Purposes.

1. Removes oxide and cleans metal.

2. Makes solder flow more easily.

3. Cleaning helps solder stick to the metal.

B. Types.

1. Corrosive.

a. Best for general use.
b. Not used on electrical connections.
c. Must be washed off with warm water after soldering.

2. Non-corrosive.

a. Used on all electrical work.
b. May be used on all other types.

3. Several forms.

a. Liquid.
b. Powder.
c. Paste.
d. Solid.

4. Many different kinds of flux. Must be sure to match the flux to the metal.

IV. Tinning a Soldering Iron.

A. Soldering iron must be tinned before it will pick up solder.

B. Procedure.

1. Heat the iron to a dull cherry red.

2. Smooth the surface with a file if necessary.

3. Apply flux to the hot iron, sal ammoniac or resin.

4. Melt solder into a brick with a depression chisled into it.

5. Rub the heated soldering iron back and forth through the molten solder.

6. Wipe off excess solder with a damp cloth.

7. Make sure fumes are ventilated.

V. Soldering Electrical Connections. (Transparency 2)

A. Remove insulation and clean the ends of both wires.

B. Splice the wires twisting them together.

C. Apply a non-corrosive flux.

D. Heat the wire with a soldering gun until the wire is hot enough to melt the solder. Do not melt the solder with the gun.

E. Let the solder cover the splice completely flowing into all spaces.

F. Remove excess solder.

(Caution: Do NOT solder a ground connection. An overloaded circuit may cause the wires to heat the solder. Use solderless connectors.)

VI. Soldering Copper Tubing.

A. Clean the pieces to be soldered with sandpaper.

B. Apply flux to the pieces.

C. Fit the pieces together as they are to be soldered.

D. Light the propane torch.

1. Open the valve slightly on the torch.

2. Hold a striker to the burner and spark it.

3. After the torch lights, adjust the valve to desired flame.

4. Allow the torch to warm up before operating in an inverted position.

E. Heat the tubing until hot enough to melt the solder. Heat evenly.

F. Apply solder around the joint. Do not leave any gaps. Allow the solder to flow between the pieces.

Student Learning Activities:

1. Have the students examine different types of soldering equipment.

2. Have the students examine different types of solder and flux and determine what each is used for.

3. Demonstrate tinning a soldering iron and soldering electrical connections and copper tubing.

4. Have the students practice soldering until proficient.

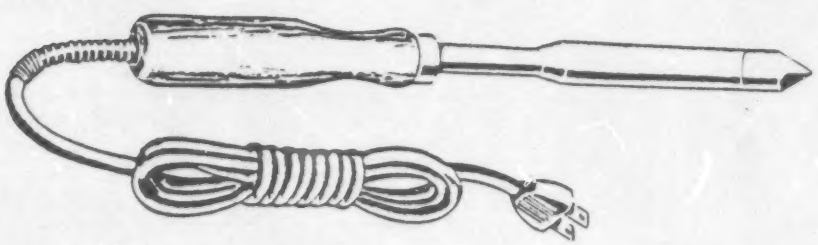
5. Have the students complete the soldering exercise on the following page.

Copper Tubing Soldering Exercise

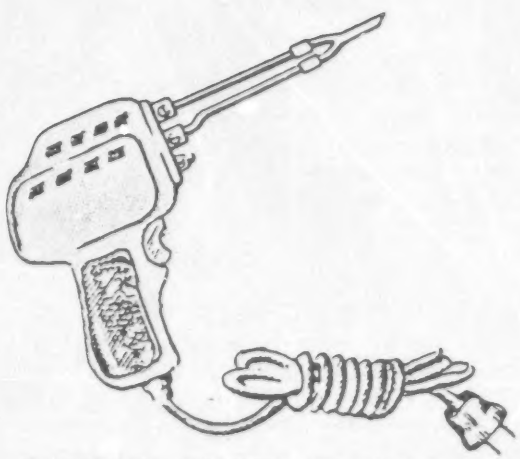
1. Obtain a short piece of copper tubing (4-5 inches) and a fitting (coupling, elbow, or tee).
2. Clean the surfaces to be soldered with sandpaper or emery cloth.
3. Apply flux to both surfaces.
4. Clamp one end in a vise so that the joint may be easily accessed with the torch.
5. Light the torch and allow it to warm up.
6. Heat the area of the joint evenly.
7. Check the tempurature of the tubing occaisionally by removing the torch and applying solder to the joint. When the solder readily melts, apply solder evenly around the joint, leaving no gaps. The solder should flow into the joint regardless of the position if the flux has been properly applied.
8. Wipe off the excess solder.
9. Allow the tubing to cool.
10. Have the instructor check your work.

TYPES OF SOLDERING EQUIPMENT

SOLDERING IRON



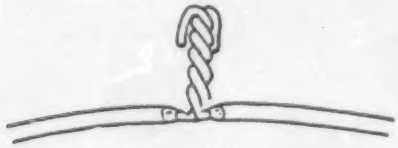
ELECTRIC SOLDERING IRON



ELECTRIC SOLDERING GUN

PROPANE TORCH

SOLDERING AN ELECTRICAL SPLICE



Twist Wire Ends and Flux

Solder the Splice

Flow Solder Into All Spaces